Inquiry Lesson Plan

Grade/Content Area	9th Grade – Common Core Math Curriculum
Lesson Title	Adding and Subtracting Polynomials
State Standards:	Common Core State Standards **Arithmetic with Polynomials and Rational Expressions A -APR** **Perform arithmetic operations on polynomials [Linear and Quadratic]** **A-APR.1** Understand that polynomials form a system analogous to the integers, namely, they are close under the operations of addition, subtraction, and multiplication; add, subtract, and multiply.
Context of the Lesson	The students are about half way through a unit on exponential numbers and polynomials. Today's material is planned for about 45 minutes of the 50-minute period, leaving a little space if needed at some point. This lesson will allow students to apply their knowledge of exponents, evaluating powers, multiplying and dividing, combining like terms, and squares/square roots.
Opportunities to Learn	**Differentiated Instruction** - Using multiple intelligences is helpful when including all students. It is imperative to be creative with the lessons and include a least one intelligence. Students will have many different opportunities to learn when the lesson is inventive and includes everyone. - Students will be in groups, this allows them to ask peers for assistance. Some adolescents may be more comfortable asking a friend rather than the teacher. A teacher will also be around to help. Because they will be interacting and moving around, everyone will have the opportunity to develop their own conclusions of the lesson. - Students are allowed to come to the classroom at any time for additional help or practice. For enrichment I will offer the students basic skills practice and extra curriculum practice for those who want to take on a

	challenge. **Accommodations and Modifications** The curriculum is straightforward enough for most of the class to comprehend. For those who need accommodations or modifications, they are done in advance and prepared for the day of the lesson. This lesson (and all other lessons) is designed to meet the needs of each student. For students with more severe disabilities I will alter the assignment (either by length or difficulty*, depending on the student*). If beneficial, iPads or an equivalent will be provided for those who need additional assistance. **Environmental Factors** This class is composed of 20 students (8 boys and 12 girls). The classroom is set up to be inviting to all students. Students need to be welcomed and know that they all have a significant role in the class. If a teacher represents him/herself as the main focus, the children may be intimated and not want to be involved. The classroom will be arranged into five groups of four students. The groups will be chosen to ensure that every student has the opportunity for the best education. Each group will vary with diverging talents and skills. The students will remain in their groups the during the entire 45 minute lesson. Besides from interacting with the whole class there will be time for individual and cooperative group learning. Students will be able to work as a group for any class assignment or activity. Any student accommodations will be made and all students, even those with a learning disability, are expected to do their own personal best. **Materials:** Algebra Tiles, Document Camera, Group activity
Objectives	It is important for students to understand how mathematical ideas interconnect and build on one another to produce a coherent whole. - When students have completed this lesson they should be able to use physical models to perform operations

	with polynomials. - Students should be able to add and/or subtract polynomials with integer coefficients. - Given the different scenarios the students will be able to model and solve problems using diverse representations, such as graph, tables, and equations.
Instructional Activities and Tasks	***Planned for a 45/50 minute block*** As the students come in they should get their in class folder where they can submit assignments, get new assignments, keep important documents, submit entry/exit activity, etc. **Launch (15 min)** With anticipation, the students have watched the online videos demonstrating adding and subtracting polynomials. They were asked to take notes on the fundamental material. 1st video: http://www.sophia.org/polynomial-addition-and-subtraction/polynomial-addition-and-subtraction--5-tutorial 2nd video: http://www.sophia.org/adding-and-subtracting-polynomials--2/adding-and-subtracting-polynomials--5-tutorial 3rd video: http://www.sophia.org/adding-and-subtracting-polynomials-in-the-real-world/adding-and-subtracting-polynomials-in-the-real-wor--3-tutorial As the students enter the classroom they will complete their entry activity, found in their folders. This should take no longer than 3-4 min and be placed in the submit bin at the front of the room. I will start the class by reviewing prior knowledge of monomials, binomials, polynomials and exponential numbers. I will do a few examples on the document camera and I will ask the students to work along in their notebook. If anyone has any questions, concerns, or recommendations, they are encouraged to share. For the linguistic learners, I will refresh their memories with the

definition of a polynomial.

- *Definition*: When we add or subtract monomials, we get a polynomial. For example, the following are all polynomials: $7x + 2$, $11y^2 - y + 4$, $6ab - b^3$. Each monomial within is called a term of the polynomial. For example, $5x$ and 3 are the terms of $5x + 3$.

- *Review of prior knowledge*

  a) Properties of Exponential Numbers

  $3^2 * 3^5 = (3 * 3)(3 * 3 * 3) = 3^5$

  $(4^2)^3 = 4^2 * 4^2 * 4^2 = (4 * 4)(4 * 4)(4 * 4) = 4^6$

  b) Adding/Subtracting Monomials

  $3x^2 + 5 - 7x^2 + 12$

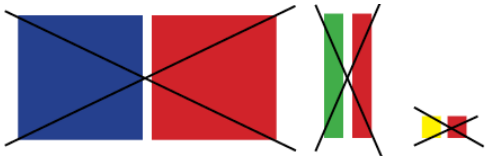
  $3x^2 + 5 - 7x^2 + 12$ *Identify like terms*

  $3x^2 - 7x^2 + 5 + 12$ *Rearrange like terms*

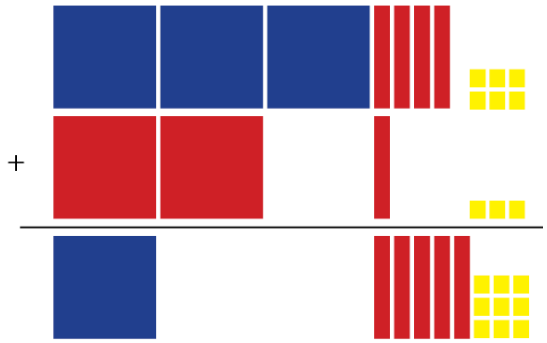
  $-4x^2 + 17$ *Combine like terms*

I will tell the students that they will be learning a very important lesson today and these new skills will form the foundation for many other math lessons. I will remind the students about the values of algebra tiles and explain what each one represents. *(In case they forgot)*

Review zero pairs on the document camera. It is important to clarify that adding a zero pair to the polynomial does not change its value because the zero pairs are equal to zero.



At this point, I will pass out the student sets of algebra tiles. To check understanding, I will use the document camera to create several equations with the tiles. I will ask students to describe what is represented.

	▪ *Example:*  Students have previously worked with algebra tiles, therefore they *should* immediately know this represents $2x^2 + 4x - 3$ **Explore (20 min.)** - To get the activity started, I will present them with a question and give an opportunity to use algebra tiles to represent the problem. By doing this, they will use the process of combining like terms to simplify. A student that feels comfortable enough will be asked to give a demonstration to the class. - *Example:* Find the sum of $(3x^2 - 4x + 6) + (-2x^2 - x + 3)$  - Now each group will be presented with an activity sheet. Each group will be working with a different scenario. It is important for the students to realize that this skill will be very useful to outside of school. Every student will have a set of algebra tiles and be able to equally participate in their group. - While the groups are working I will be circulating around the room making sure the students are on track and offering guiding questions. - *"Does this answer make sense?"* - *"When the question is asking for the area of the land around the house. What must you subtract from the area of the entire property?"*

	- If any student appears to be doing most of the work in the group I will ask probing questions and get the discussion going.
	  - *"How does that compare with what you said before?"*
	  - *"Could you tell me more about that, please?"*
	  - *"What, specifically, will you do next?"*
	  - *"Is that all? Is there anything you have missed out?"*
	
	- If a group is struggling I will attempt to start at the most basic instruction and ask them to work from there. (Scaffolding)
	  - *"I have noticed what you have done so far, why don't you back track a little and try starting with this step and working forward from here."*
	
	Summarize (10 min)
	Discuss follow up questions as a review for the class.
	  - How are like terms combined?
	  - Can you describe like terms with the algebra tiles?
	  - When two binomials are added, will the sum always, sometimes, or never be a binomial?
	Remind students that polynomials are incredibly important in mathematics.

Assessment	**Launch** Students are able to generalize their previous knowledge to answer and validate the entry activity given at the very beginning of class. This activity is short and designed to conclude whether students watched the online videos. The intent of the videos is not to specifically teach the students, but to give them a good understanding of the approaching lesson. Watching the videos allows for fewer lectures and more practice in class. While the students are practicing addition and subtraction operations on polynomials I will browse through the entry slips. If any students seem entirely lost I will discretely observe how they are performing in class. **Explore** In class, the students will be given group work and expected to complete it (*at least as much as they can*). During class I will be able to tell if the students have

	conquered the computational portion of the lesson or if there is a lack of understanding. I will observe what the students completed in groups and determine whether or not the skill was mastered with accuracy according to the common core standards. **Summarize** If the students/group answers are thought out and complete then I will be able to see that they met the objectives and understand the content of the lesson. I will observe the level at which the student has answered the questions too. This will give me a good idea of what level the child is at.
Self Reflection	▪ Did I have enough time to explain the lesson? ▪ Did the students understand everything I was asking them to do? ▪ Were the majority of the questions easy/moderate/hard for the students? ▪ Did the students pass the assessment part of the lesson? ▪ Did the activity activate prior knowledge?

Name _____ Date_____

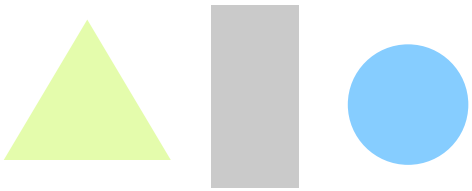
ENTRY ACTIVITY

Complete the following problem

(Recall techniques from the videos and previous knowledge)

If you are unsure how to solve, explain what *you think you should do*

$$(2x^2 - x) + (x^2 + 3x - 1)$$



Name _____ Date_____

PURPLE GROUP

FIND THE SUM OR DIFFERENCE. USE ALGEBRA TILES TO DEMONSTRATE Each member of the group completes one problem. Take turns and explain each problem to each other.

1. $(x^2 - 4x + 3) + (3x^2 - 3x - 5)$

2. $(-x^2 + 3x - 4) - (2x^2 + x - 1)$

3. $(-3x^2 + x + 8) - (x^2 - 8x + 4)$

4. $(5x^2 - 2x - 1) + (-3x^2 - 6x - 2)$

5. **BUILDING A FENCE** Matt plans to build a fenced in dog pen. At first, he planned for the dog pen to be square, with a length x on each side, but then he decided that a square may not be the best. He added 4 to the length and subtracted 3 from the width

a. Draw a diagram to show the dimensions of the new pen.

b. Write a polynomial that represents the amount of fencing that Matt will need for the new dog pen. Use algebra tiles to demonstrate.

c. How much fencing will Matt need if x=8 or if x =15?

GROUP DISCUSSION When two binomials are added, will the sum always, sometimes, or never be a binomial?

Name _____ Date_____

BLUE GROUP

FIND THE SUM OR DIFFERENCE. USE ALGEBRA TILES TO DEMONSTRATE Each member of the group completes one problem. Take turns and explain each problem to each other.

1. $(4x^2 - 2x - 9) + (-5x^2 + x - 7)$

2. $(7x^2 + 2x - 3) - (-9x^2 - 2x + 3)$

3. $(4x^2 - 7x + 2) - (-x^2 + x - 2)$

4. $(4x^2 + 2x - 5) + (-3x^2 - 2x + 4)$

5. **BUILDING A HOUSE** You are planning to build a house that is $1\frac{1}{2}$ times as long as it is wide. You want the land around the house to be 20 feet wider than the width of the house, and twice as long as the length of the house, as shown at the right.

a. Draw a diagram to show the dimensions of house and the property.

b. Write a polynomial that represents the area of the land surrounding the house. Use algebra tiles to demonstrate.

c. If x=30 feet, what is the area of the house? What is the area of the entire property?

GROUP DISCUSSION When two binomials are added, will the sum always, sometimes, or never be a binomial?

Name ANSWER Key Date_____

ENTRY ACTIVITY

Complete the following problem

(Recall techniques from the videos and previous knowledge)

If you are unsure how to solve, explain what *you think you should do*

$$(2x^2 - x) + (x^2 + 3x - 1)$$

$(2x^2 + x^2) + (-x + 3x) + (-1)$ • Group like terms

$3x^2 + 2x - 1$ • Combine like terms

$$3x^2 + 2x - 1$$

Sample Group Activity

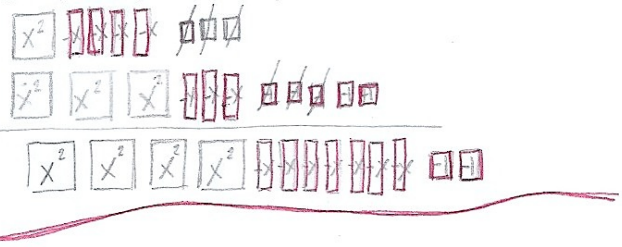
Name ANSWER KEY Date_____

PURPLE GROUP

FIND THE SUM OR DIFFERENCE. USE ALGEBRA TILES TO DEMONSTRATE Each member of the group completes one problem. Take turns and explain each problem to each other.

1. $(x^2 - 4x + 3) + (3x^2 - 3x - 5)$

$4x^2 - 7x - 2$



2. $(-x^2 + 3x - 4) + (2x^2 + -x + 1)$

$-3x^2 + 2x - 3$

3. $(-3x^2 + x + 8) + (x^2 + 8x + -4)$

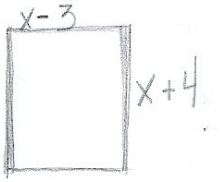
$-4x^2 + 9x + 4$

4. $(5x^2 - 2x - 1) + (-3x^2 - 6x - 2)$

$2x^2 - 8x - 3$

5. **BUILDING A FENCE** Matt plans to build a fenced in dog pen. At first, he planned for the dog pen to be square, with a length x on each side, but then he decided that a square may not be the best. He added 4 to the length and subtracted 3 from the width

a. Draw a diagram to show the dimensions of the new pen.



b. Write a polynomial that represents the amount of fencing that Matt will need for the new dog pen. Use algebra to demonstrate.

$2(x-3) + 2(x+4) \overset{\text{equiv}}{=} (x-3) + (x-3) + (x+4) + (x+4)$

$= (2x-6) + (2x+8) = \boxed{4x + 2}$

c. How much fencing will Matt need if x=8 or if x =15?

$x = 8$: $4 \cdot 8 + 2 = 34$

$x = 15$: $4 \cdot 15 + 2 = 62$

GROUP DISCUSSION When two binomials are added, will the sum always, sometimes, or never be a binomial?

Sample Group Activity

Name ANSWER KEY Date_____

BLUE GROUP

FIND THE SUM OR DIFFERENCE. USE ALGEBRA TILES TO DEMONSTRATE Each member of the group completes one problem. Take turns and explain each problem to each other.

1. $(4x^2 - 2x - 9) + (-5x^2 + x - 7)$

$-x^2 - x - 16$

2. $(7x^2 + 2x - 3) + (+9x^2 + 2x + 3)$

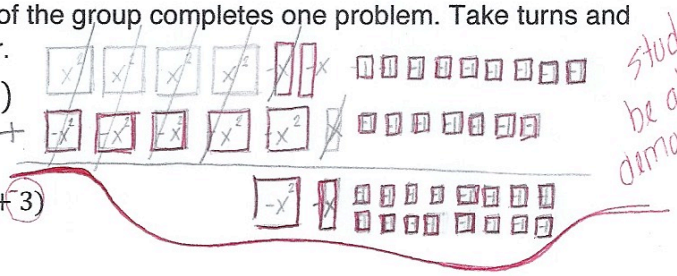
$16x^2 + 4x - 6$

3. $(4x^2 - 7x + 2) + (+x^2 + x + 2)$

$5x^2 - 8x + 4$

4. $(4x^2 + 2x - 5) + (-3x^2 - 2x + 4)$

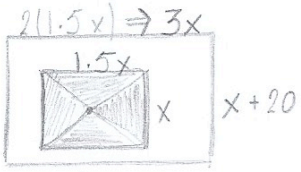
$x^2 - 1$



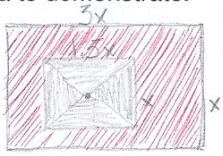
students must be able to demonstrate like this.

5. **BUILDING A HOUSE** You are planning to build a house that is $1\frac{1}{2}$ times as long as it is wide. You want the land around the house to be 20 feet wider than the width of the house, and twice as long as the length of the house, as shown at the right.

a. Draw a diagram to show the dimensions of house and the property.



b. Write a polynomial that represents the area of the land surrounding the house. Use algebra to demonstrate.



→ We want the red shaded area
• students must recall the area of a rectangle and distributive property

$(3x(x+20)) - (1.5x \cdot x) = (3x^2 + 60x) - (1.5x^2)$

$= 1.5x^2 + 60x$

c. If x=30 feet, what is the area of the house? What is the area of the entire property?

→ area of house $= 1.5x \cdot x = 1.5x^2 \overset{x=30}{=} 1.5 \cdot 30^2 = 1350$ ft

→ area of property $= 3x(x+20) = 3x^2 + 60x \overset{x=30}{=} 3 \cdot 30^2 + 60 \cdot 30 = 4500$ ft

GROUP DISCUSSION When two binomials are added, will the sum always, sometimes, or never be a binomial?